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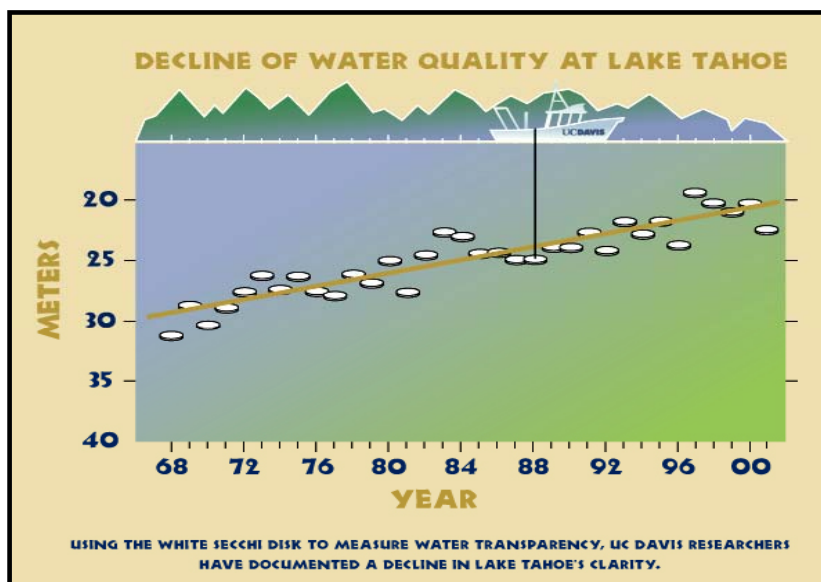
LAKE TAHOE SEDIMENT AND NUTRIENT TMDL PROBLEM STATEMENT

Lake Tahoe Hydrologic Unit; Alpine, El Dorado, Placer Counties

Problem Overview

Continuous, long-term monitoring and evaluation of water quality in Lake Tahoe since the early 1960's has shown that Lake Tahoe is impaired by declining clarity attributable to an increase in algae production and the addition of fine sediments (particle sizes ranging from 0.5 to 2 microns in diameter). Fine particles in this size range settle out extremely slowly and remain in suspension for an indefinite period of time, given the great size and depth of Lake Tahoe and the degree of lake mixing. Fine particles decrease clarity directly and nutrients such as phosphorus and nitrogen decrease clarity indirectly by stimulating algae production. The lake is currently phosphorus limited as a result of high nitrogen loading, though control of nitrogen is still important because of the co-limiting nature of nitrogen and phosphorus on algal growth.

The combination of these factors has resulted in a decline in Lake Tahoe's famed clarity at a rate of nearly one foot per year, as depicted in the figure below. This long-term trend in clarity loss is both statistically significant ($p < 0.001$) and is now perceptible to even the casual observer. If the loss of clarity continues at this rate, the condition will also be accompanied by a change of lake color and trophic status.



Historical Secchi depth record since 1969 as measured by the University of California, Davis Tahoe Research Group (C.R.Goldman). Values represent annual means from approximately 30 measurements per year.

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Because of Lake Tahoe's great size and depth, nutrients and fine sediments remain in the water column and can be recycled for decades. As a consequence, these pollutants are accumulating and progressively contributing to the decline in Lake Tahoe's clarity.

Project Area Description

Geography

The physical setting of Lake Tahoe is striking, situated near the crest of the Sierra Nevada mountains at an elevation of approximately 6,225 feet above sea level. The California–Nevada state line splits the Lake Tahoe Basin watershed, with about three-quarters of the watershed's area and about two-thirds of the lake's area lying within California. The geologic basin that cradles the lake is dominated by impressive mountains, steep slopes and erosive, nutrient-poor granitic soils; volcanic rocks and soils are also present in some areas. The lake's montane-subalpine watershed is predominantly vegetated by mixed coniferous forests that shelter the 63 tributaries that feed Lake Tahoe. The lake has one outlet, which forms the start of the Truckee River, which ultimately drains to Pyramid Lake, a terminal lake in Nevada.

Lake Tahoe is the eleventh-deepest lake in the world with a depth of 1,465 feet, more than a quarter of a mile. The bottom of the lake is hundreds of feet below the elevation of Carson City, Nevada, in the adjacent Great Basin. At nearly two hundred square miles, the surface area of the lake covers nearly two fifths of the Tahoe Basin, and the lake holds nearly 39 trillion gallons of water. So much water resides in Lake Tahoe that it takes nearly seven hundred years for the average drop of water entering the lake to travel through and out to the Truckee River.

Pollutant Sources and Land Use Considerations

The Tahoe Basin is a changing landscape, and, today, significant portions of this once pristine region are urbanized. Studies from 1962-1999 have shown that many factors have interacted to degrade the Basin's air quality, terrestrial landscape, tributary streams, and the lake. The contributing factors include land disturbance, increasing resident and tourist population, habitat destruction, air pollution, soil erosion, road construction and maintenance, and loss of wetlands and other areas for natural infiltration of runoff. In order to determine the total existing pollutant loads to Lake Tahoe and the reductions necessary to achieve water quality standards, it is necessary to quantify the sources and relative loading of nutrients and sediment by distinct land use classifications. For this purpose, land uses have been classified into the following categories: Commercial, Industrial, Residential, Roads, Recreation, General Forest, and Intervening Areas.

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Listing Basis

The Clean Water Act establishes a regulatory framework for restoring degraded water bodies to conditions of full environmental functionality. This framework includes establishing beneficial uses for all surface waters, upon which water quality standards are based. The standards include both narrative and numeric criteria that are adopted to protect the beneficial uses. If a water body does not achieve its water quality standards, it is considered water quality-limited, or impaired, and is placed on a list of waters for which a total maximum daily load (TMDL) must be developed. When implemented, the TMDL will result in the water body fully attaining its uses and standards.

Beneficial Uses

Beneficial uses of Lake Tahoe identified in the Basin Plan include: municipal and domestic supply (which includes, but is not limited to, drinking water supply); agricultural supply; ground water recharge; navigation; water contact and non-water contact recreation (which include swimming, fishing, and aesthetic enjoyment, among other activities); commercial and sportfishing; cold freshwater habitat; wildlife habitat; preservation of biological habitats of special significance (such as established parks, refuges, sanctuaries and ecological reserves); migration of aquatic organisms; and spawning, reproduction, and development of fish and wildlife. The key beneficial use that is currently not being attained is non-contact water recreation (i.e., aesthetic enjoyment of Lake Tahoe's historical clarity).

Water Quality Standards

The standard for water transparency, which implements the beneficial use related to aesthetic enjoyment of Lake Tahoe, is the key water quality objective that is not being met. A discussion of the transparency standard and other related standards is provided below.

Transparency

For Lake Tahoe, transparency, as measured by Secchi disk observations, shall not be decreased below the levels recorded in 1967-71, based on a statistical comparison of seasonal and annual mean values. According to data collected by the UC Davis Tahoe Research Group (TRG), the mean annual values are presented below, with the resulting 1968-71 annual mean Secchi depth being 29.7 m.

<u>Year</u>	<u>Secchi Depth (m)</u>	<u># Observations</u>
1968	31.2	29
1969	28.6	29
1970	30.2	27
1971	28.7	22

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Clarity

The vertical extinction coefficient shall be less than 0.08 per meter when measured below the first meter. When water is too shallow to determine a reliable extinction coefficient, the turbidity shall not exceed 3 Nephelometric Turbidity Units (NTU). In addition, turbidity shall not exceed 1 NTU in shallow waters not directly influenced by stream discharges. The Regional Board will determine when water is too shallow to determine a reliable vertical extinction coefficient based upon its review of standard limnological methods and on advice from the TRG.

Biostimulatory Substances

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect the water for beneficial uses. Biostimulatory substances include nutrients such as nitrogen and phosphorus. Numeric objectives for Total Nitrogen and Total Phosphorus in Lake Tahoe are 150 micrograms per liter (ug/L, as N) and 8 ug/L (as P), respectively.

Biological Indicators

Algal productivity and the biomass of phytoplankton, zooplankton, and periphyton shall not be increased beyond the levels recorded in 1967-71, based on statistical comparison of seasonal and annual means. The numeric criterion for algal productivity (or Primary Productivity, PPr) is $52 \text{ g C m}^{-2} \text{ y}^{-1}$ as an annual mean. Clarity and transparency are linked primarily with aesthetic beneficial uses. Other water quality indicators that may be used in TMDL development include dissolved oxygen, turbidity, algal growth potential, plankton counts, and suspended sediment.

Nondegradation

All water bodies of the Lahontan Region are subject to a nondegradation objective which requires continued maintenance of high quality waters. As stated in the Basin Plan, the State Board in 1980 designated Lake Tahoe as subject to the highest level of protection under the nondegradation objective, that of an Outstanding National Resource Water (ONRW), both for its recreational and its ecological value, and stated:

“Viewed from the standpoint of protecting beneficial uses, preventing deterioration of Lake Tahoe requires that there be no significant increase in algal growth rates. Lake Tahoe’s exceptional recreational value depends on enjoyment of the scenic beauty imparted by its clear, blue waters. ...Likewise, preserving Lake Tahoe’s ecological value depends on maintaining the extraordinarily low rates of algal growth which make Lake Tahoe an outstanding ecological resource.”

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Section 114 of the federal Clean Water Act also indicates the need to “preserve the fragile ecology of Lake Tahoe.”

Impairment

Since the 1960s, declining transparency and increasing phytoplankton productivity due to increased sediment and nutrient loading has impaired Lake Tahoe. Declining lake clarity has been documented by TRG since 1968 using Secchi depth and other water quality measurements. Water clarity has been declining by an average of 0.25 meters per year. This decline affects aesthetics directly and recreation indirectly. Aquatic life and spawning may be impaired by reduced clarity. Periphyton that are dependent on light penetration may decline at deeper depths due to reduced clarity. Sediment, especially fine sediment, directly affects clarity, and these fine particulates are not removed by conventional stormwater treatment systems. The nutrients nitrogen (N) and phosphorus (P) indirectly affect water clarity by increasing the primary productivity of waters for phytoplankton.

The table below depicts the long-term trends in Primary Productivity (Reuter, 2000). The recovery of low Primary Productivity values following the Comstock era disturbance (extremely high soil erosion due to deforestation in the Tahoe Basin) indicates that Lake Tahoe may recover from the current high Primary Productivity if proper controls are instituted in a timely fashion.

Era	Time Period	Value*
Before Comstock Logging	up to 1861	27
Comstock Logging	1861-1898	176
Post Comstock Logging	1900-1969	29
Modern Urbanization	1970-1991	95
Current	1991-	160+ (5-6% increase/year)

* Primary Productivity in Lake Tahoe ($\text{g C m}^{-2} \text{ y}^{-1}$)

Current approaches to watershed management have been beneficial to water quality and greatly improved our understanding of management techniques. However, these approaches have not provided the magnitude of improvement required to meet water quality objectives. This is of particular importance given the current rate of clarity decline and the necessity to halt this trend before the opportunity to do so is irrevocably lost.

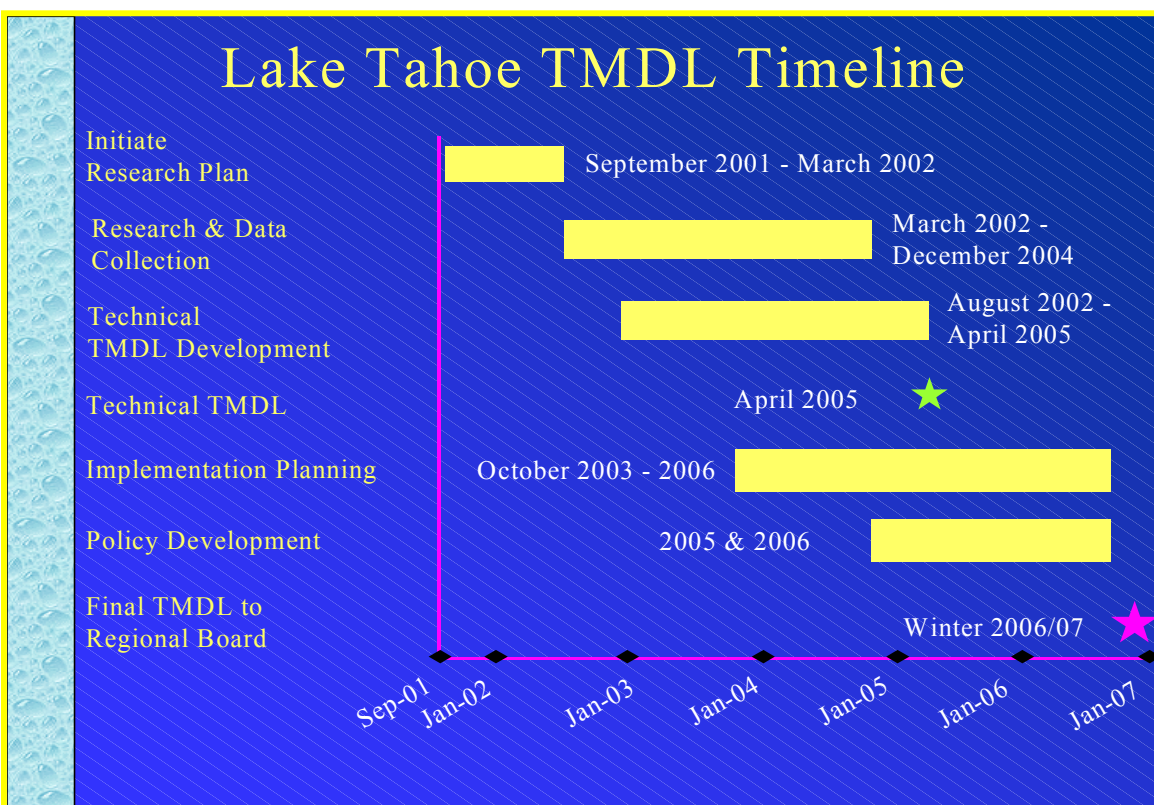
The current loading of nutrients and fine particulates has resulted in continuous non-attainment of water quality standards established by the Tahoe Regional Planning Agency, Lahontan Regional Water Quality Control Board (LRWQCB), the Nevada Division of Environmental Protection (NDEP) and the U.S. Environmental Protection

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Agency. Both the LRWQCB and the NDEP list Lake Tahoe as “water quality limited” under Section 303(d) of the Clean Water Act.

Schedule/Status

Research projects necessary to refine our current understanding of the major contributing sources of fine sediments and nutrients, and their effect on Lake Tahoe’s clarity, are underway. For purposes of establishing the TMDL, two years of new monitoring data (Water Years 2003 and 2004) will be collected and interpreted, combined with a wealth of historical data, and applied to the calculation. Lake response modeling will be conducted in early 2005, resulting in a final ‘technical’ TMDL being developed and distributed for public review by May 2005, as indicated in the timeline below.



Simultaneous with the final stages of TMDL development, LRWQCB will also be undertaking substantial research on how the necessary pollutant load reductions may be achieved. From April 2003 through June 2006, best management practices (BMPs) for reducing all pollutant sources will be evaluated and eventually combined into a number of alternative scenarios or combinations that will achieve the necessary total load reduction established by the TMDL. Participating agencies and other stakeholders will be provided opportunities for involvement through public education, technical workshops, and discussion of implementation scenarios. Final TMDL adoption will

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involve a high degree of public review and input. The LRWQCB expects that public interest will be especially significant during the load allocation phase when necessary load reductions are appropriated and an implementation plan is developed. The final TMDL will be adopted by the LRWQCB and NDEP by January 2007 and submitted to the U.S. EPA for review and approval. This process will be conducted in accordance with the requirements of the California Environmental Quality Act (CEQA). Following its adoption, the TMDL can be revised in the future as additional information is developed and following review of progress toward its implementation.